OPERATING INSTRUCTIONS FOR THE EXPERIMENTAL PATH-LOSS ANALYZER DEVELOPED UNDER

Contract 7850/79-5401-69WR

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1.0 INTRODUCTION

This manual gives operation instructions and maintenance data on the Path Loss Analyzer developed by Raytheon under Contract 7850/79-5401-69WR. Since the Path Loss Analyzer is intended for laboratory study of various phenomena, the operating instructions given can only be of a general nature. The operator will be required to develop specific techniques to fit the experiments to be performed.

The Path Loss Analyzer consists of a microwave transceiver and a target, which acts as a modulable antenna/reflector. The target is set up in an environment to be evaluated and illuminated by the transceiver. Both the signal received at the target and the signal reflected to the transceiver can then be observed on an oscilloscope display in terms of amplitude versus frequency as the transceiver is automatically swept or manually tuned through its frequency range.

The target is an antenna consisting of three dipoles capable of operating in all or any one of three mutually perpendicular axes.

2.0 DESCRIPTION AND THEORY OF OPERATION

2.1 Target Antenna

The target antenna consists of two modules, the antenna itself and the pre-amplifier module, which functions as the antenna mounting base. Figure 1 is a photograph of the Target Antenna. A Plexiglas rod is supplied which is used to mount the antenna to the base. The rod is in two sections to provide flexibility in the mounting. The target antenna, the preamplifier module and the mounting rod are packaged in a large suitcase along with some of the interconnecting cable as shown in Figure 2.

2.1.1 Preamplifier Module

The preamplifier Module/Mounting Base contains a preamplifier for each of the three dipole antennas and a modulator driver. The input to the preamplifiers is detected video, as each antenna has an integral diode detector.

Each pre-amplifier is connected to its corresponding dipole antenna through a polarized color coded cable. The modulator driver (chopper) is also connected through the same kind of cable and connector.

"Z" = Green-Vertical
"X" = Yellow-Horizontal
"Y" = Red-Horizontal
"C" = Orange-Chopper

Figure 1. Target Antenna

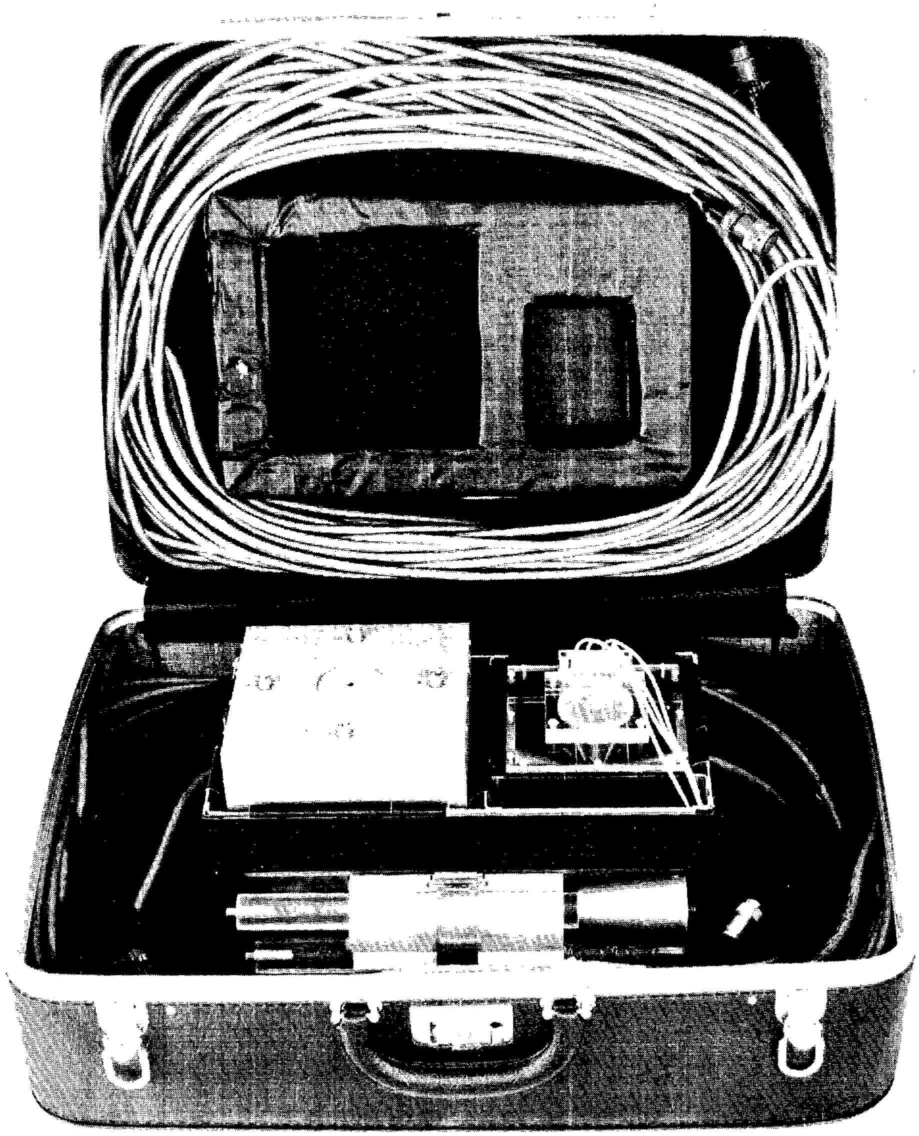

Figure 2. Target Antenna in Transit Case

The target antenna preamplifiers are tuned to the transmitter's modulation frequency of 100 kHz. Each amplifier is housed separately to provide as much electrical separation as possible. Measured cross-talk between any two channels is well below signal levels encountered. Figure 3 is a schematic diagram of the preamplifier module.

Each antenna preamplifier consists of a tuned input transformer, an amplifier, a filter, an ultralinear rectifier and a low-impedance output amplifier.

The input transformer is slug-tuned to the 100-kHz modulation frequency of the received signal. The bandwidth of the amplifier is adjustable as is the gain. All the amplifiers have been adjusted for equal gain and bandwidth.

In operation the signal received from each target antenna is 100 kHz video, varying in amplitude as the transmitter frequency is swept. The 100 kHz target received signal is amplified and then rectified and filtered resulting in a waveform corresponding to the envelope of the rf signal received at the target antenna. The envelope waveform from each dipole is sent back to the transceiver unit by means of a long cable.

2.1.2 Target Module

The antenna assembly is made up of 3 mutually perpendicular bi-cone dipoles. Each dipole has connected at its center, and in series with the two halves, a PIN diode and a 100 ohm resistor in parallel. Another diode (detector MA-41512) is reactively coupled to the first

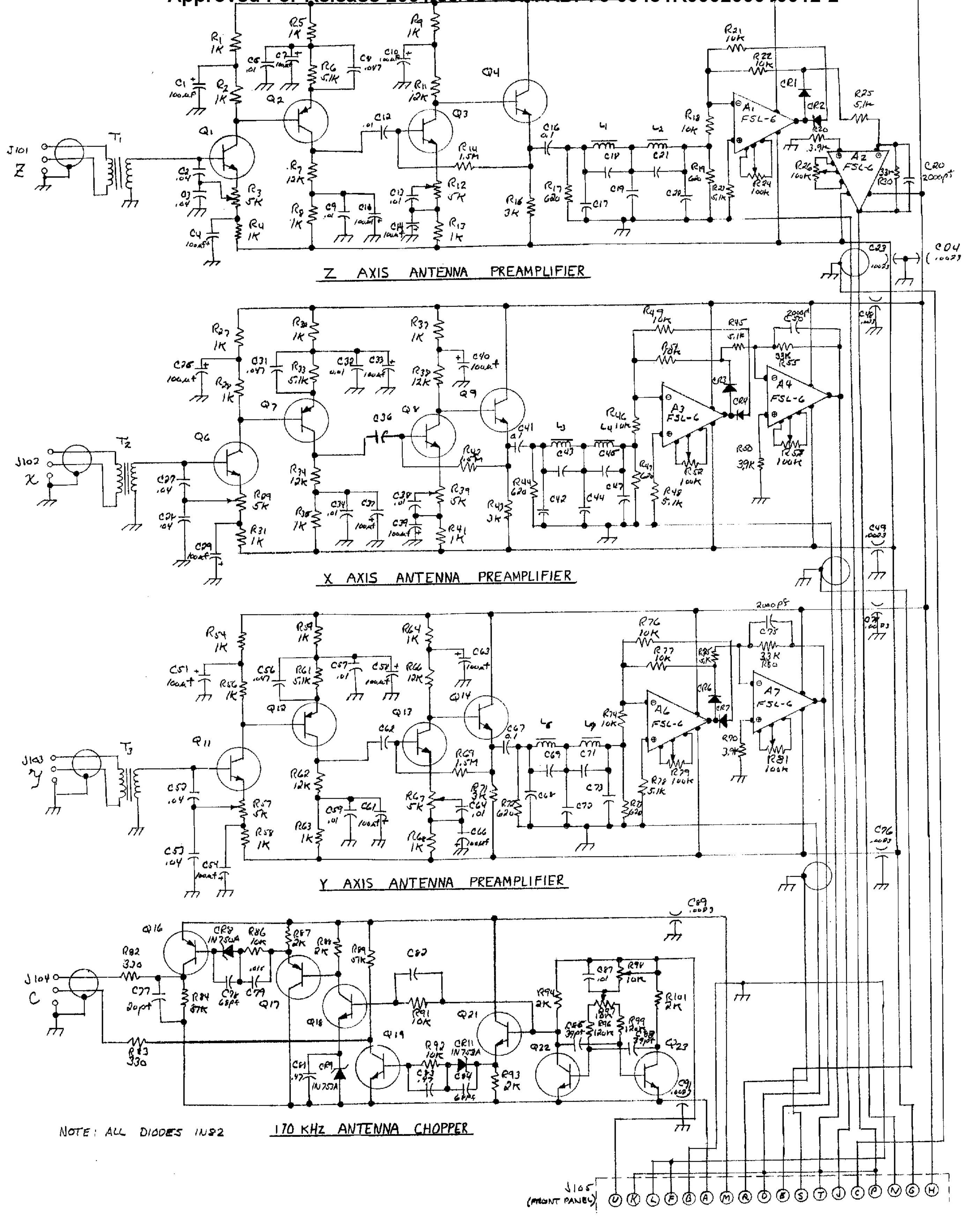

Figure 3. Target Antenna Preamplifier and 170 kHz Chopper Schematic Diagram

assembly through specially designed coaxial capacitors. The PIN diode and resistor combination forms the active elements for the switching mode. When the diode is turned on, forward biased, it shorts the dipole with a low resistance, about 30 ohms, and energy received from the transmitter is reflected. When the PIN diode is reverse biased, high resistance, the dipole is terminated in its characteristic impedance and absorbs energy from the transmitter. The PIN-diode switching rate is 170 kHz. Thus, the signal received at the target is mdoulated at a 170 kHz rate and reflected. This modulated energy is picked up by the receiving antenna back at the transceiver. Figure 4 is a sketch of a dipole antenna, one of the three in the target module, showing the mounting of the components at the apex of its cones.

2.2 Transceiver Unit

2.2.1 General

Figure 5 is a photograph of the front panel of the transceiver unit showing the connector and control layout. The transceiver consists of microwave oscillators, tuning and sweep circuits, a receiver and a power supply.

Figure 6 is a top-view photograph of the transceiver with an overlay showing the location of the circuit boards and microwave components.

Figure 7 is a block diagram of the transceiver showing the signal paths.

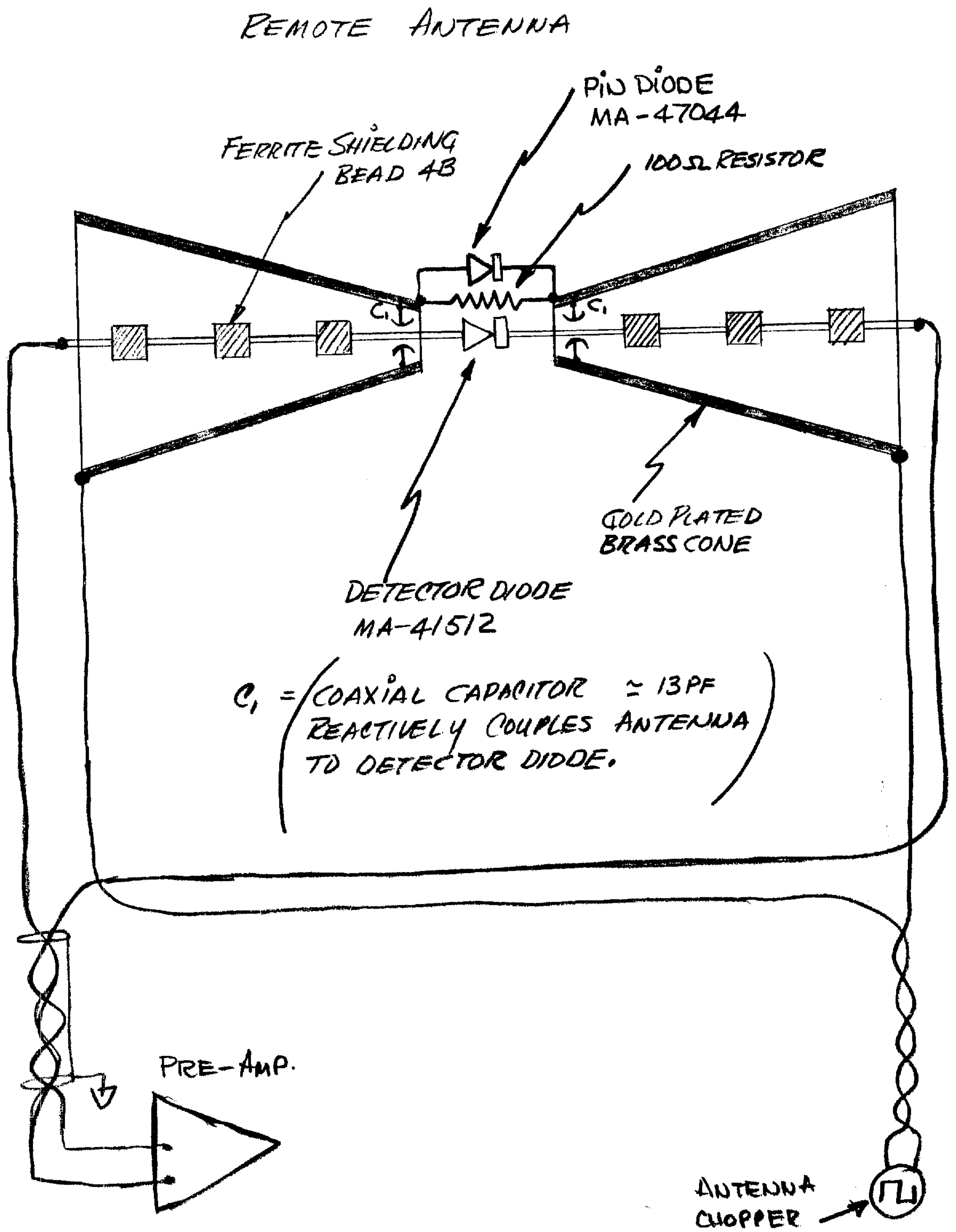

Figure 4. Detail Sketch of Target Antenna Construction

Figure 5. Transceiver Front Panel

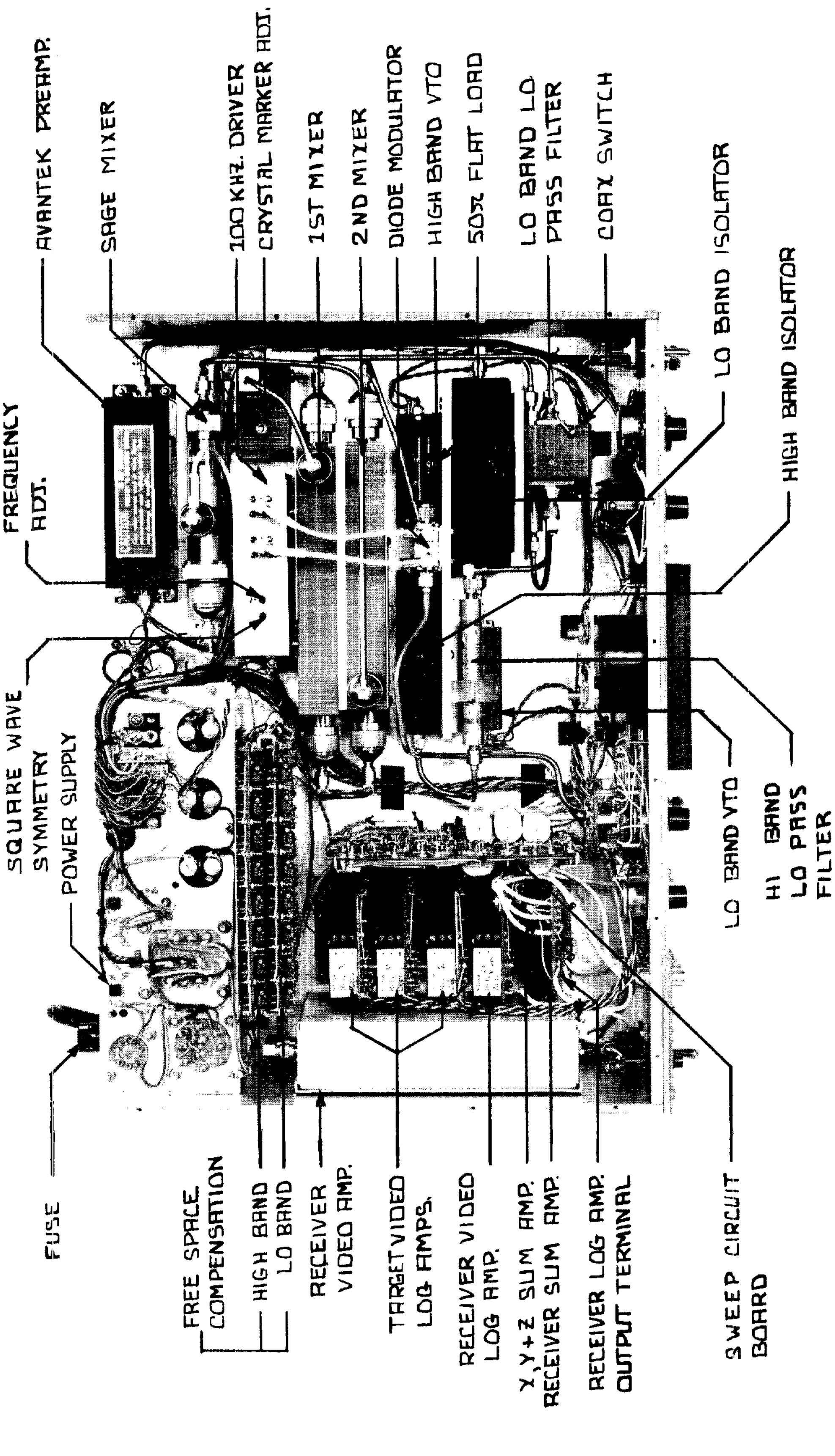

Figure 6. Transceiver Top View

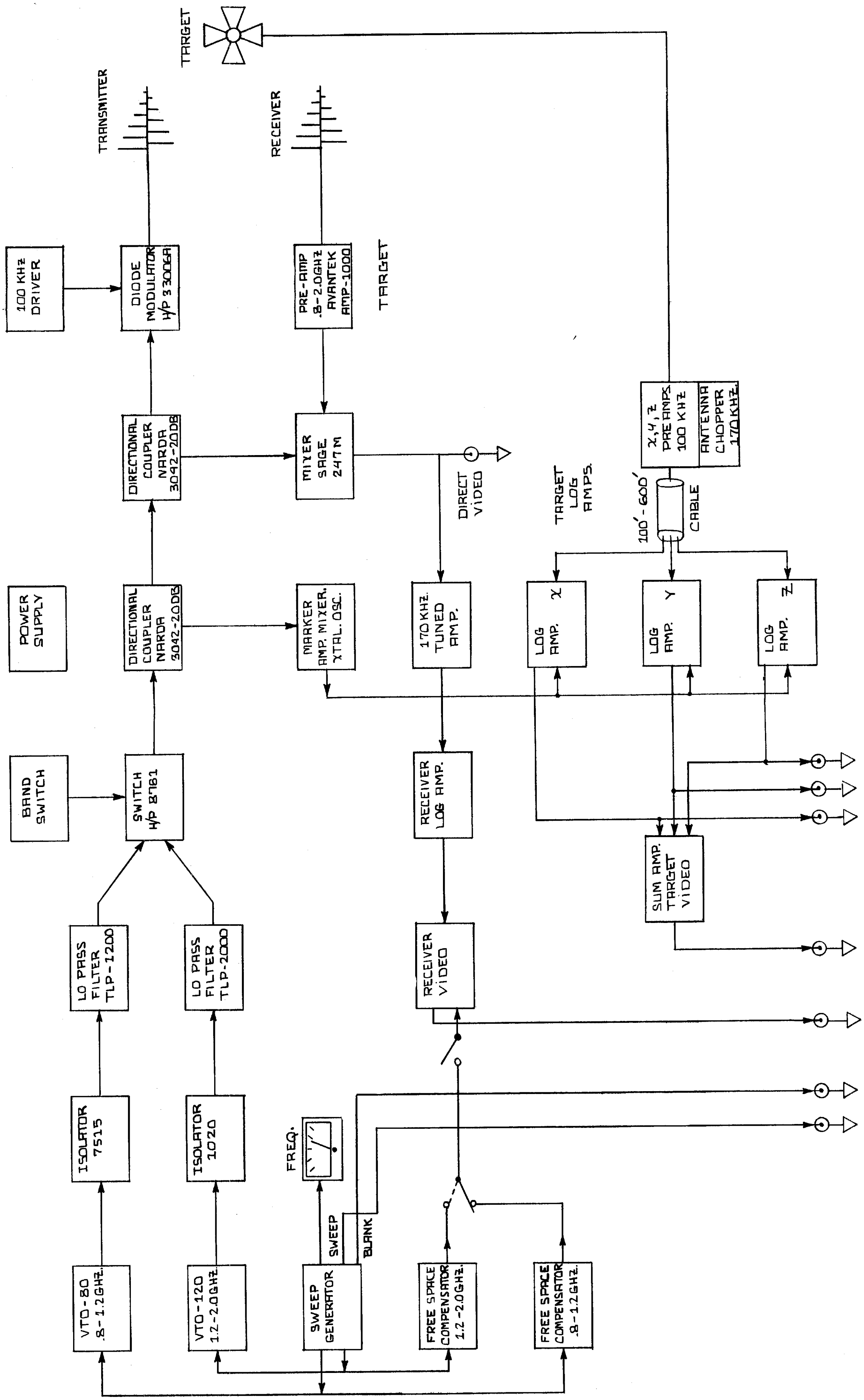

Figure 7. Transceiver Block Diagram

2.2.2 Transmitting Circuits

The microwave signal is generated by the Voltage Tuned Oscillators (VTO's) which tune from 800 MHz to 2 GHz in two bands, 0.8 to 1.2 and 1.2 to 2.0 GHz. A front-panel meter indicates the frequency to which the VTO in use is tuned, or when the VTO is swept, the center frequency of the sweep range.

The VTO's are followed by Ferrite isolators, one for each band. The isolators stabilize the loading on the VTO's. The VTO's will operate properly only if they are terminated in a low-VSWR load.

The low-pass filters are used to attenuate the strong second harmonic generated by the VTO's. The filter for the low frequency band has 3 sections. Its stop band is -50 dB at 1.6 GHz. The high-band filter has five sections; its stop band is -60 dB at 2.6 GHz. The band switch has several functions. It activates the HP-8761 microwave coaxial relay, selecting the output of either the low or high frequency VTO. It also selects the proper sweep range, free-space compensation network and the VTO's bias supply.

The first 20-dB directional coupler is used to sample the VTO's output. This swept signal is mixed in the marker amplifier with the output of a 100 MHz crystal oscillator to form marker harmonics every 100 MHz. Figure 8 is a schematic of the marker generator. The marker output is connected to the X, Y & Z log amp inputs so that the 100-MHz-spaced pulses appear on the Target Video display.

The second 20-dB directional coupler is used to take part of the VTO's output to be used as the receiver L.O. input to the Sage microwave mixer.

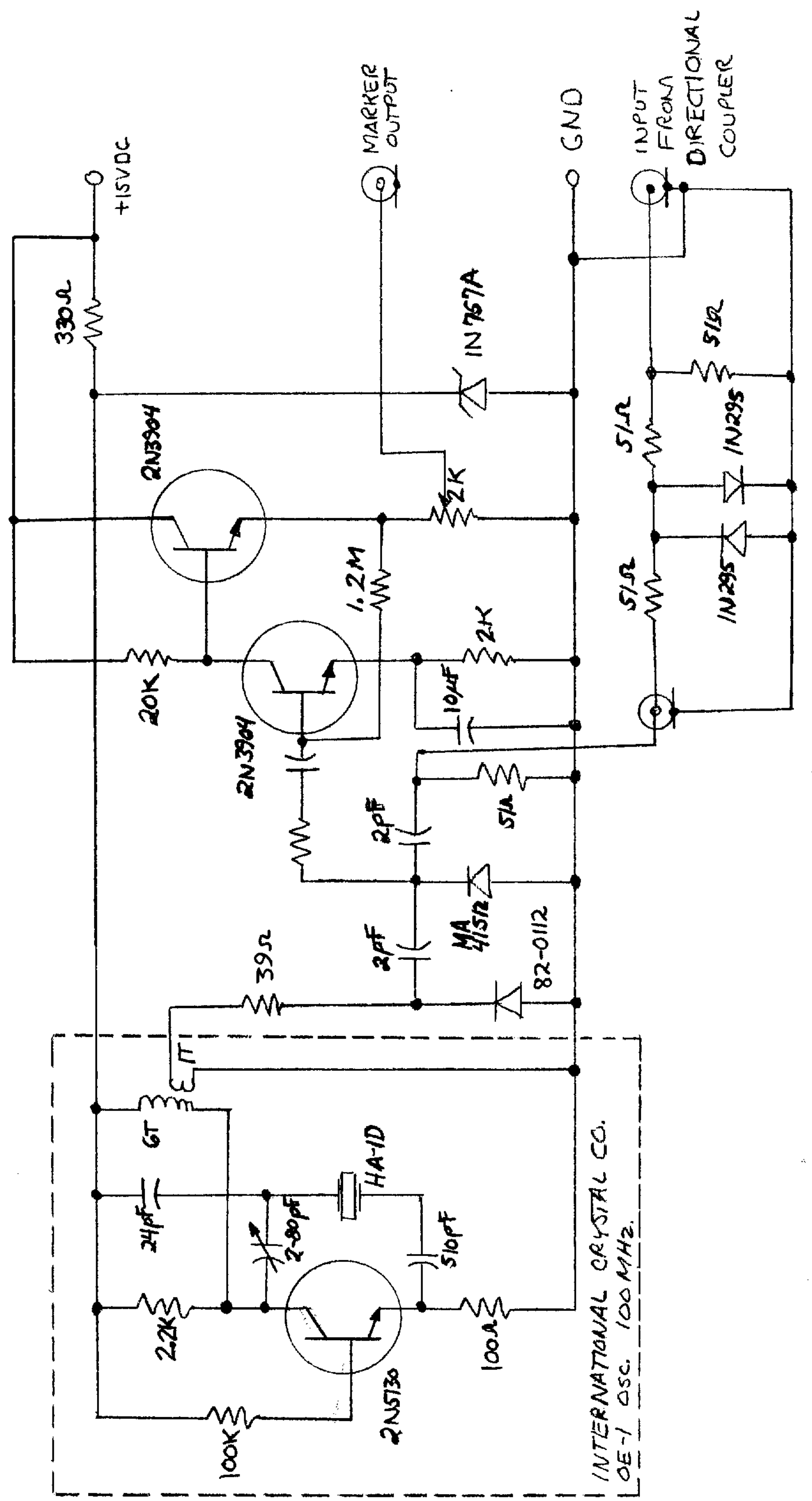

Figure 8. Marker Generator Schematic Diagram

The HP 33006A diode modulator is used to modulate the rf from the VTO's. It is a SPDT microwave switch, using PIN diodes for the switching elements. The input arm of the switch is connected to the rf source, the VTO. One output port is connected to the transmitting antenna and the other port to a 50-ohm flat load. The switch, when activated by the 100 kHz driver, alternately switches the rf fource from the antenna to the 50-ohm load at a 100 kHz rate. This type of switch was used because it has much lower VSWR than other possible choices.

The modulator driver consists of a 100-kHz square-wave multivibrator driving a two-polarity current-source for the microwave switch. Figure 9 is a schematic diagram of the 100-kHz modulator driver. The modulation switch on the front panel of the transceiver is used to turn on or off the rf modulation. When it is in the off position, the multivibrator's operation is stopped and the polarity of the two outputs to the microwave switch are such that switch's output will be connected to the antenna and not to the 50-ohm load i.e., it is in the C.W. mode.

2.2.3 Received Circuits

The input stage of the receiver is a broadband, low-noise Avantek amplifier. It has approximately 26 dB gain within the 0.8 to 2.0 GHz band. Its output is connected to the Sage mixer, which operates as a homodyne detector. The resulting video is fed into the 170-kHz tuned amplifier. To review, the received 170-kHz modulated rf signal is

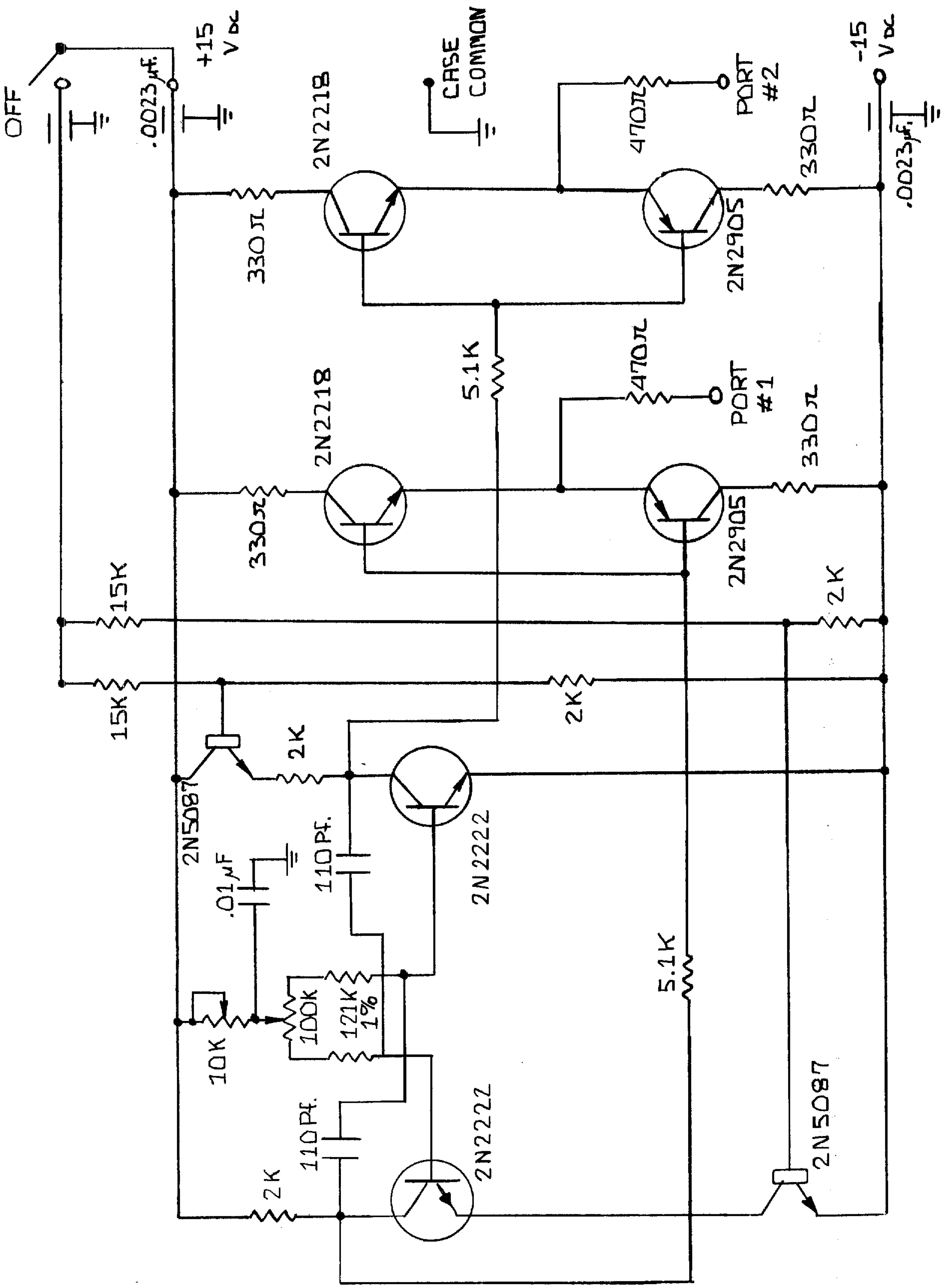

Figure 9. 100-kHz Modulator Driver Schematic Diagram

generated as follows: the transmitter is positioned so that it floods the remote target antenna with unmodulated microwave energy. The target antenna is chopped at the 170 kHz rate (i.e., it alternately is shorted and terminated in its characteristic impedance). During the shorted portion of the chopping cycle, rf energy is reflected back to the receiving antenna. This signal is amplified, mixed and detected and then all extraneous signals are filtered out in the 170 kHz tuned amplifier.

The 170 kHz tuned amplifier is similar in design to the remote-antenna tuned preamplifiers, see Figure 10. The main difference is that the bandpass frequency is 170 kHz instead of 100 kHz. The low-pass filter was eliminated in the 170 kHz amplifier because the small second harmonic of the 100-kHz transmitter modulation does not get into the 170 kHz tuned amplifier. The signal is then rectified and the dc amplified and fed into the display amplifier, consisting of a log amplifier and a video amplifier.

The receiver log amplifier takes the log of the positive dc input. The output is inverted dc (negative going). The typical transfer function of the log amp is presented in Figure 11, while the schematic diagram of the display amplifiers is shown in Figure 12.

The receiver video amplifier is used as a unity-gain amplifier. When free space compensation is desired, the compensation circuit output is summed with the receiver video to form the display wave-form.

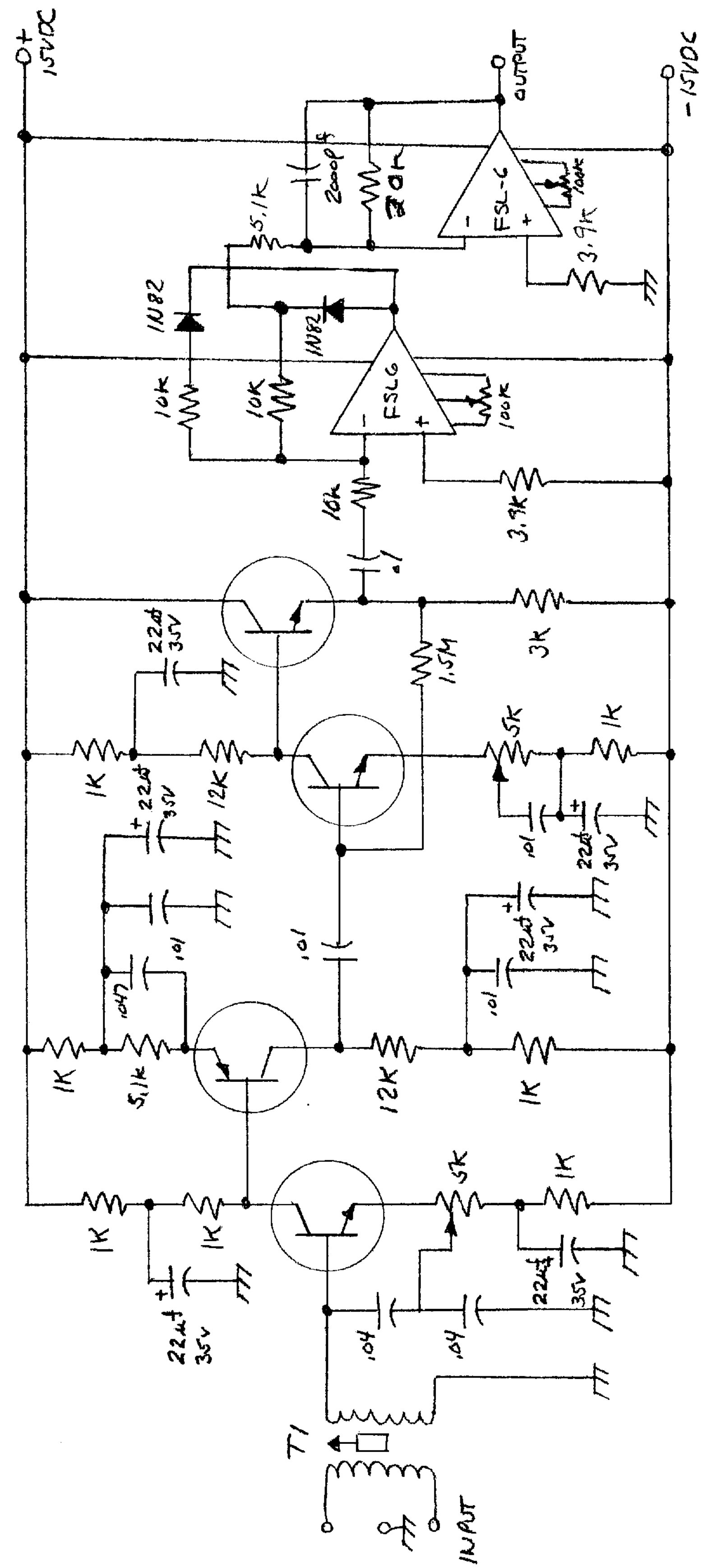

Figure 10. 170-kHz Tuned Amplifier Schematic Diagram

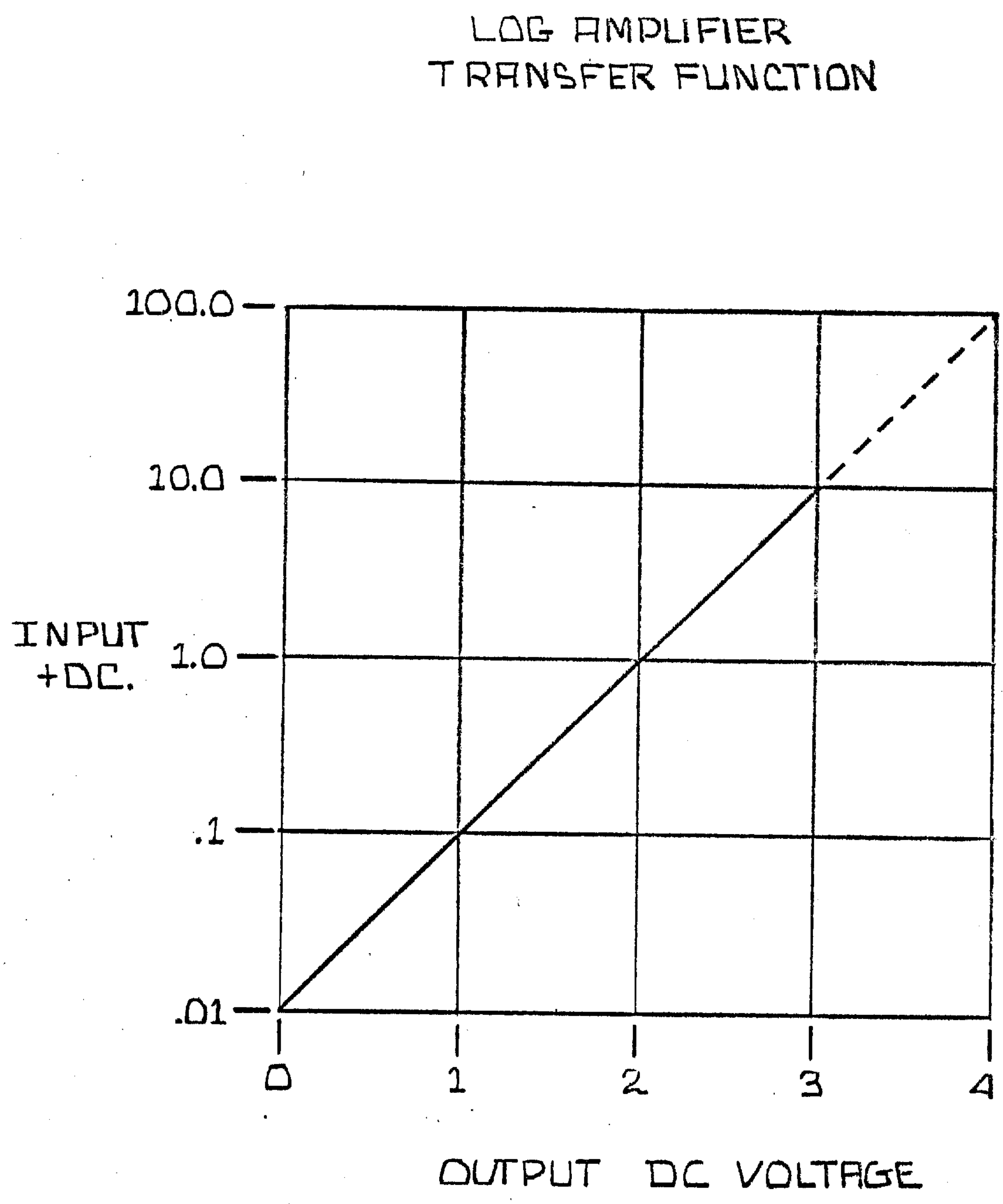

FIGURE 11. NORMAL TRANSFER FUNCTION OF LOG AMPLIFIER.

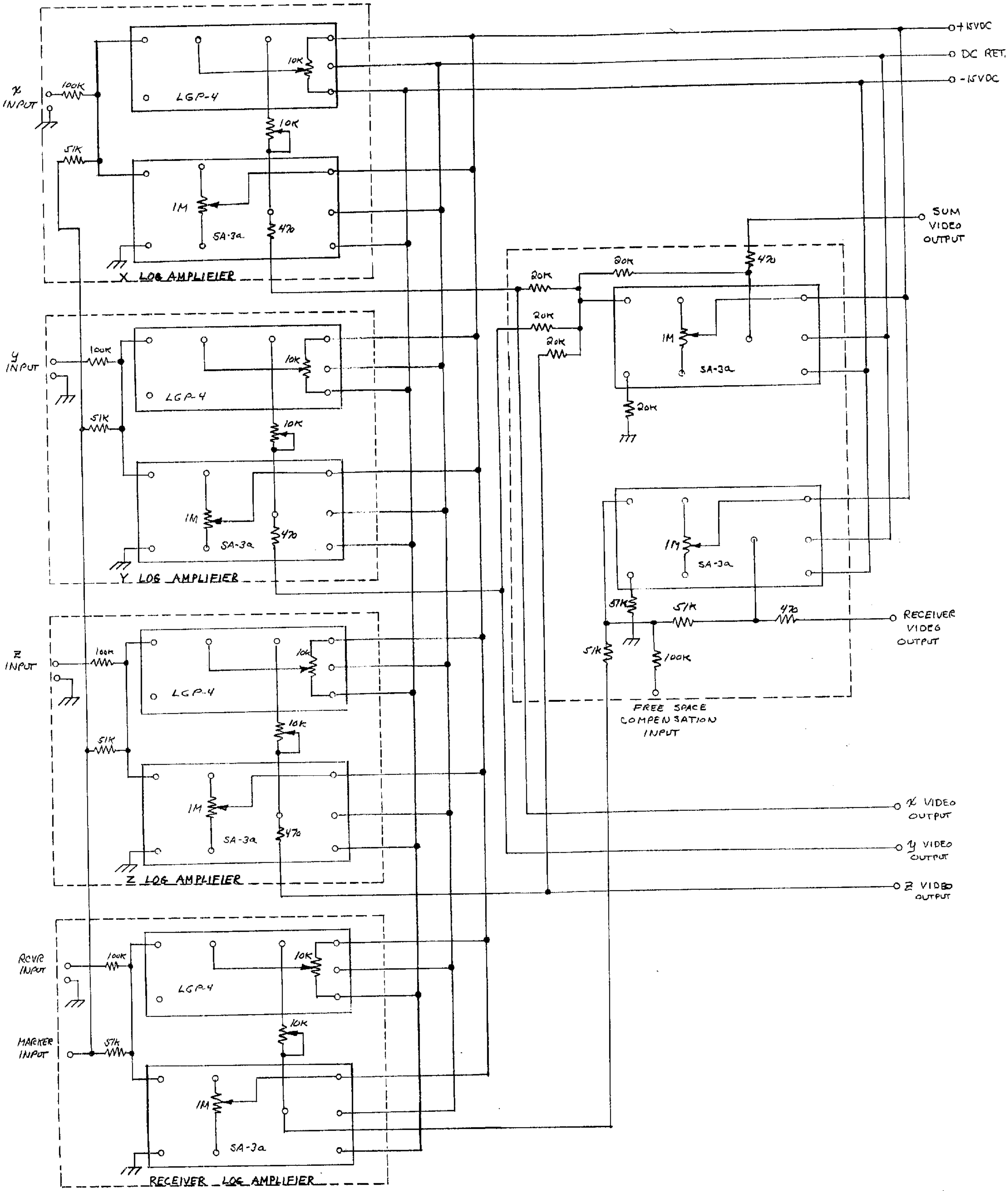

Figure 12. Display Amplifier Schematic Diagram

2.2.4 Target Video and Display Circuits

The X, Y & Z target-video log amplifiers receive their signals (through the 600 foot cable) from the target antenna. The output of the target preamplifiers is positive dc and the output for each axis is fed into its corresponding log amplifier. The log amplifiers are identical in design and operation to the receiver log amplifier. Each target log amplifier has its own front panel output.

The target video sum amplifier continuously sums and inverts the X, Y and Z outputs to give an output proportional to the total energy received by all three axes of the target. It has a panel connector and may be displayed separately.

The system has two free-space-compensation circuits, one for each of the two bands. The following discussion covers either one. Each circuit produces eight compensation segments, each segment being individually adjustable in amplitude.

In Figure 13, the free space compensation circuit schematic, there are seven Schmitt triggers, Q1 and Q2, Q8 and Q9 etc. These Schmitt triggers sense the sweep voltage and switch at the preset point between two adjacent compensation segments. As the sweep period progresses, each Schmitt trigger switches at each trigger a circuit feeding two differential amplifiers. The function of the differential amplifier is to detect when a trigger circuit has switched and to produce an output at that time. The differential output switches on the compensation control transistor, Q7, Q14, etc. When the next Schmitt trigger in the sequence switches, the differential output returns to its

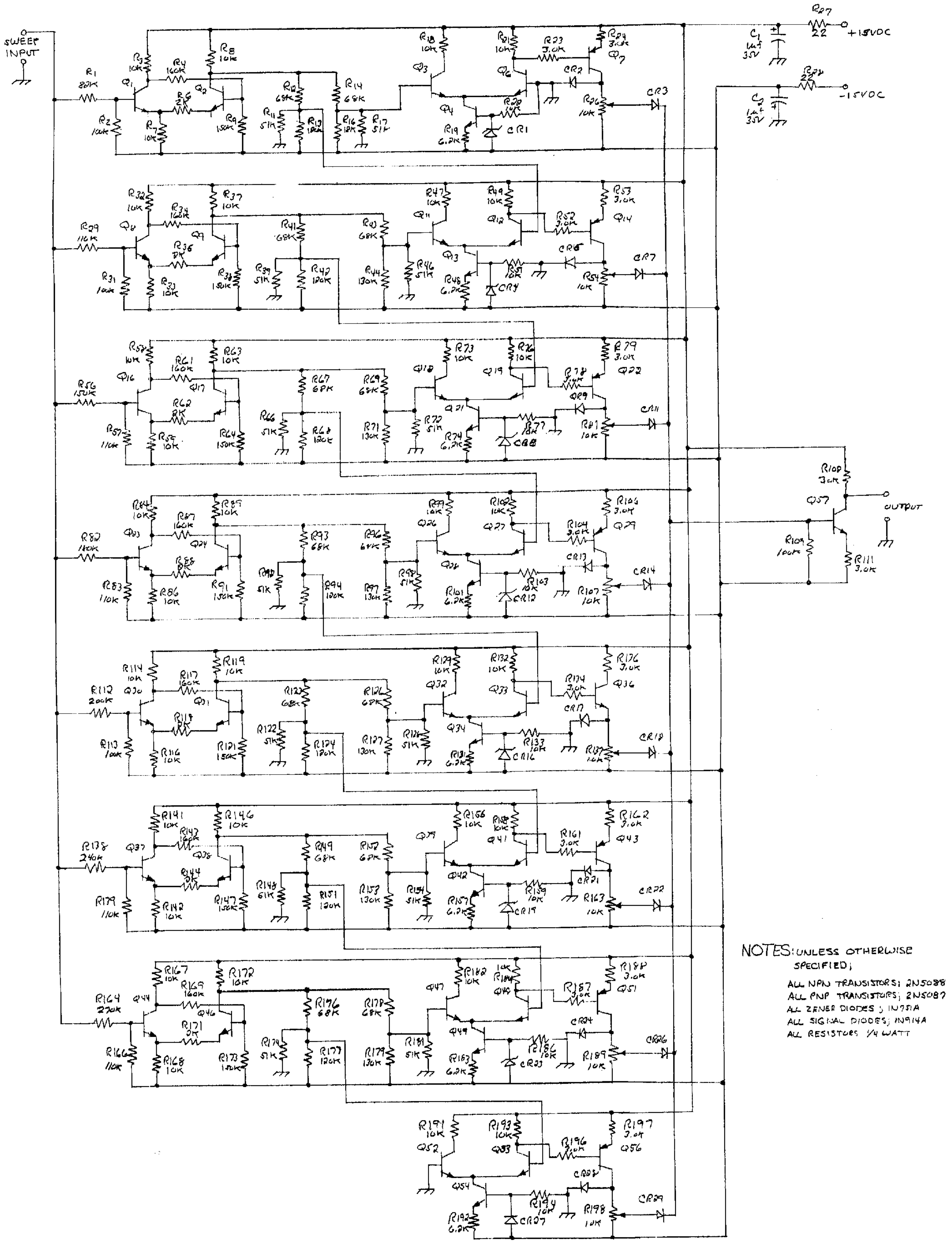

Figure 13. Free-Space Compensation Circuit Schematic Diagram

original state, turning off the compensation control transistor. Diodes CR3, CR7 etc. connect only the most positive output to the output amplifier, Q57.

An example of the operation of the circuit is as follows:

1. The sweep retraces to the beginning, resetting all circuits. All Schmitt triggers are in the off state. The input to Q3 is more negative than the input to Q6 so Q7 is on, providing the compensation output for the first segment. All the other compensation control transistors are off.

2. The sweep begins.

3. The sweep voltage reaches the switch point between the first and second segments. The Schmitt trigger composed of Q1 and Q2 switches to the on state. The input to Q3 becomes more positive than the input to Q6 causing Q7 to turn off. The input to Q12 becomes more positive than the input to Q11 turning on Q14.

This process is repeated through each segment until the end of the sweep is reached.

2.2.5 Sweep Circuit

Referring to Figure 14, the sweep circuit schematic, the sweep is generated by Q1 which operates as a constant-current source charging C1 and C2 in a linear fashion. Q3, Q4, Q6, Q7 and Q8 form an operational amplifier with a voltage gain of one, which isolates the sweep generator from its load. Q9 and Q11 are a Schmitt trigger which detects the top of the sweep and at that time turns on Q2 to discharge C1 and C2. Q13

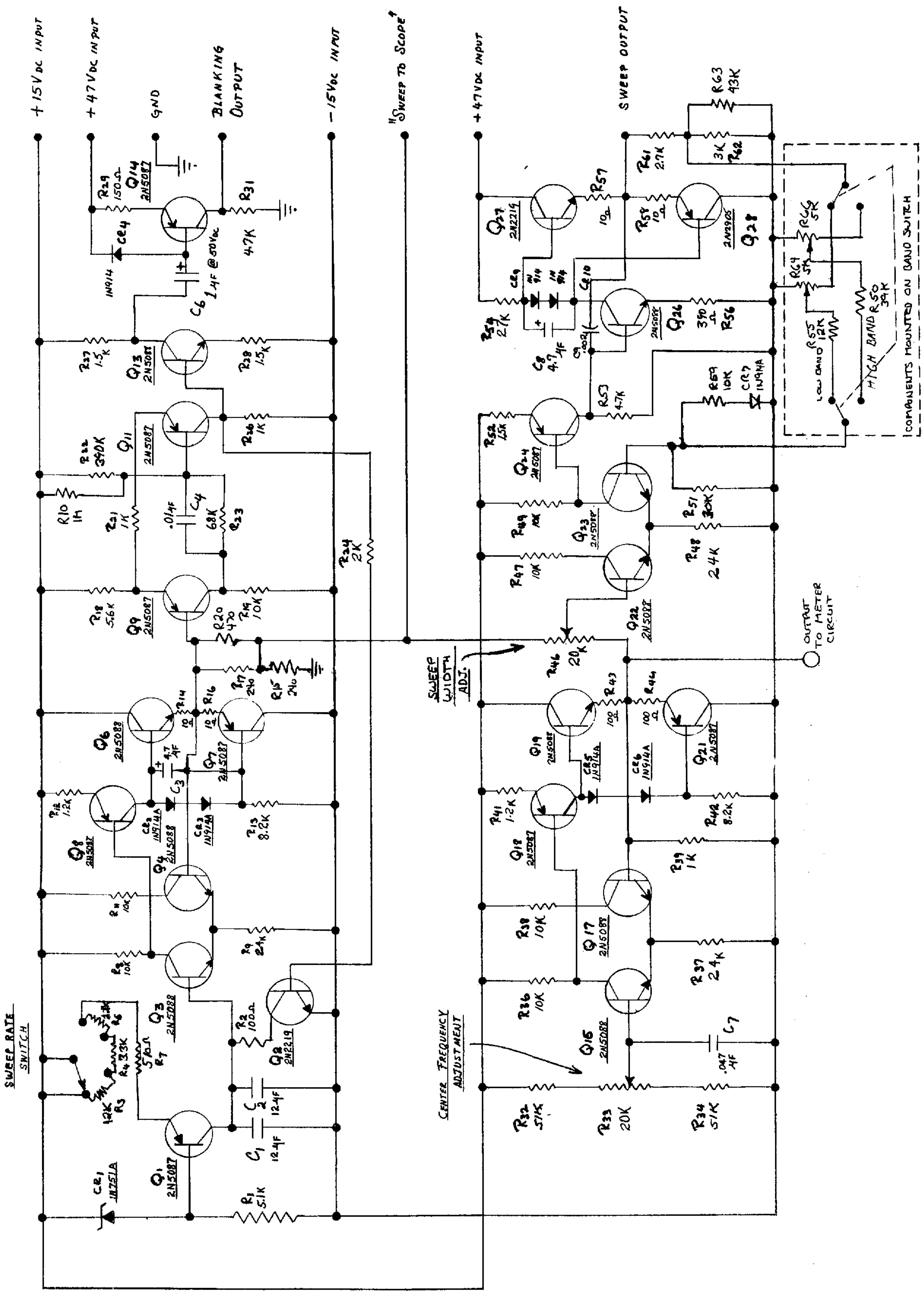

Figure 14. Sweep Circuit Schematic Diagram

and Q14 amplify the Schmitt trigger output pulse for use as display blanking.

R33 is mounted on the front panel and is the CENTER FREQUENCY control. Q16, Q17, Q18, Q19 and Q21 form an operational amplifier use to isolate the load from the control to provide good frequency stability. R46 is the front panel SWEEP WIDTH control. The sweep generator with full sweep voltage is at one end of the control range and the center frequency control voltage is at the other end. The circuit is designed such that the center frequency control has less effect as the sweep is increased, and at zero sweep width the center frequency control has full control of the frequency. This circuit prevents the output frequency from going out of the normal tuning range with any and all control settings.

Q22 through Q28 form an operational amplifier which provides the required low output impedance for the sweep output. The front-panel band switch changes the feedback network to provide the proper sweep voltage for each VTO.

The sweep circuit provides an output to the meter amplifier, shown in Figure 15. The meter amplifier sets up the proper scale factors and adjustments to provide an indication of center frequency.

2.2.6 Power Supply

The power supply module produces four separate outputs, +15 V dc, -15 V dc, -20 V dc and +47 V dc. The first three voltages listed are regulated while the fourth, +47 V dc is only lightly regulated by a Zener diode.

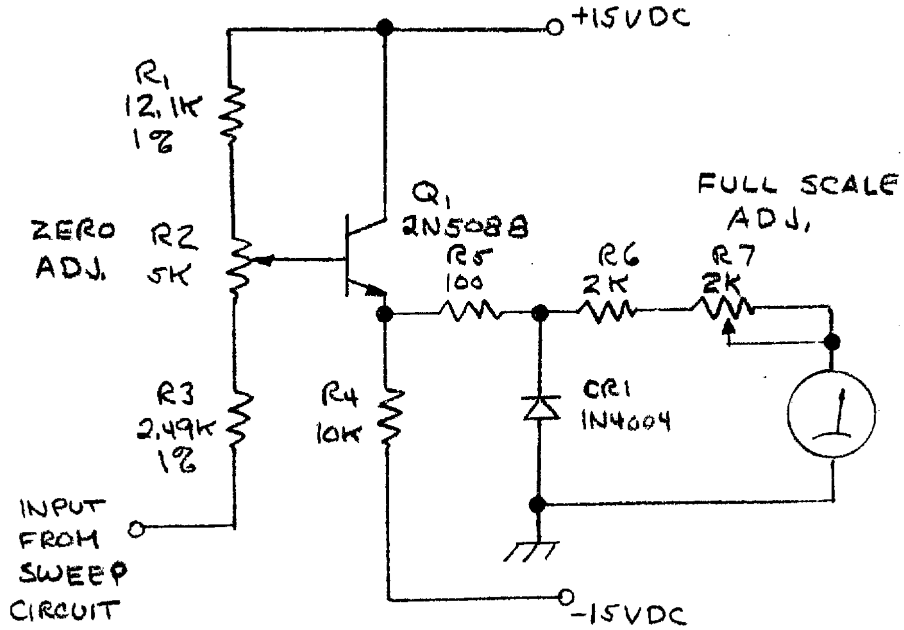

Figure 15. Meter Amplifier

Referring to Figure 16, the power supply schematic, it may be seen that the ± 15 V dc is supplied from a single transformer, T1. In the +15 V dc supply, Q1 is a constant current source, Q2 is a Darlington amplifier driving Q3. The output voltage is compared with the voltage on CR2 by the differential amplifier, Q6 and Q7. The current supplied by Q1 is divided between Q2 and Q7. If the output voltage should rise, the current drawn by Q7 will increase leaving less current to drive Q2 resulting in less current drawn by Q3 with a corresponding drop in output voltage, correcting the error. Q4 acts as a current sensor. When the voltage across R7 exceeds a preset amount, in this case about 1 volt, Q4 draws current, reducing the amount available to Q2. The current-limit point is set to approximately 450 milliamps. The -15 V dc and -20 V dc supplies are similar in operation to the +15 V dc supply except that since the polarity of the output is reversed, the transistors are reversed in polarity with the exception of the series-control transistors which are all NPN types.

The +47 V dc supply is considerably simpler than the others since the regulation requirements on that output are minimal. CR6 merely limits the output voltage to 47 volts. If heavier currents are drawn, the output voltage drops slightly.

The transceiver unit is packaged in a suitcase for transit as shown in Figure 17.

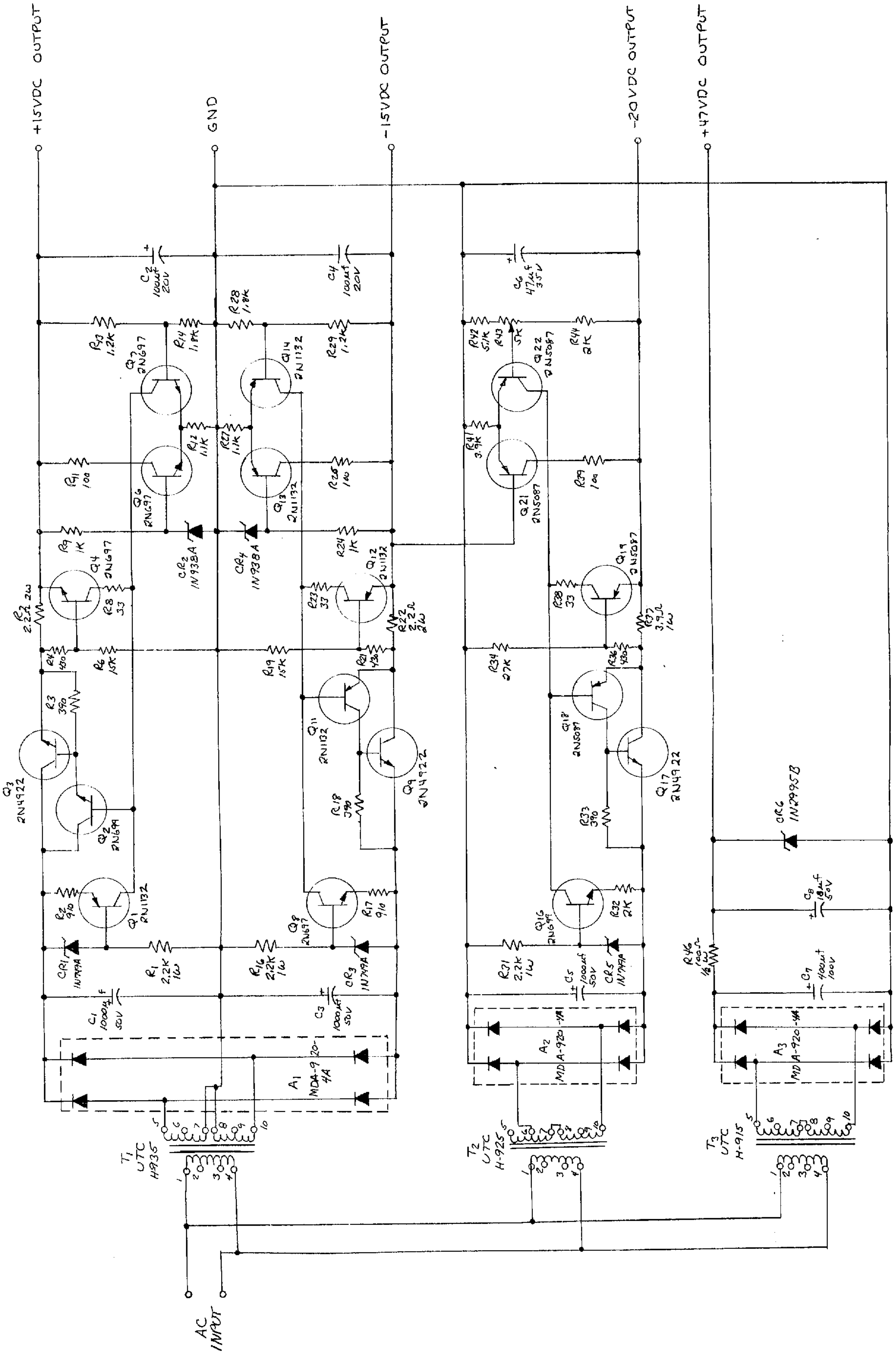

Figure 16. Power Supply Schematic Diagram

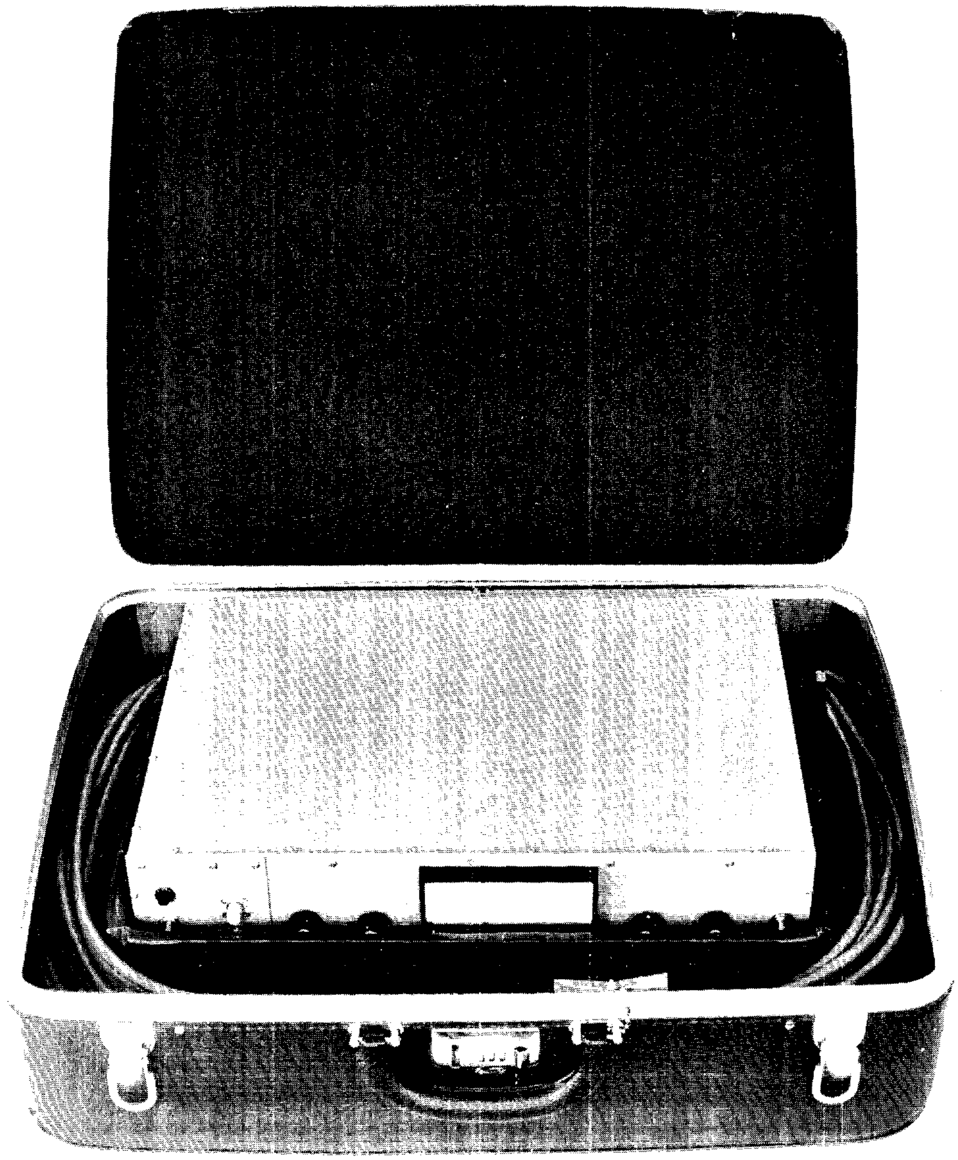

Figure 17. Transceiver in Transit Case

3.0 OPERATION OF THE PATH LOSS ANALYZER

3.1 Equipment Supplied

a) Path Loss Analyzer transceiver
b) Target antenna
c) Antenna base
d) Antenna Support Rod
e) R. F. Cable 2 pcs
f) Multi-Conductor Cables 4 pcs:
   1 ea., 100'
   2 ea., 150'
   1 ea., 200'
g) Target Amplifier Calibrator

3.2 Additional Equipment needed for Operation

a) Tektronix Oscilloscope 545-536 with 1A4, 4-Trace Plug-in
b) BNC, RG58/U Cables
   4 ea. BNC on both ends 2.5' long
   1 ea. BNC one end & GR Plug on other 4.0'
   1 ea. BNC on both ends 4.0'
c) Tripods 3 ea.
d) Transmitting Antenna
e) Receiving Antenna

3.3 Setup and Adjustment

All of the front panel controls and connectors are labeled. The inter-connecting multi-conductor cable is connector coded. Unpack and handle the target antenna carefully; it is a delicate structure. A word of caution: the insulating material used in the construction of the bi-cone antenna is plexiglass which is not high strength material. Also, the nylon screws should not be tightened! All these materials while not strong are low loss at microwave frequencies. These materials have the least effect on the antenna patterns. The two-piece supporting rod is also made of plexiglass. The jointed rod should be screwed together carefully - just enough torque to make the joint rigid. The rod should be screwed carefully into the base of the bi-cone assembly. The aluminum end of the rod may then be threaded into the antenna base. The triax cable connectors may then be plugged in. Please match the color coding on each cable.

Next connect the multi-conductor cable between the transceiver and the target. There are four multi-conductor cables - one 100'; two 150' and one 200'. The 100' cable may be identified by the yellow shrink tubing on each end of the cable. This is the master cable, without it one cannot operate the system. The master cable is always connected to the transceiver. If additional cable length is needed, the cable should be added between the target antenna and the other end of the master cable that is connected to the transceiver. This cable supplies all the power for the target antenna, and target video is returned to the transceiver in the cable. The next step is to connect the receiving and transmitting antennas to the transceiver through the

RG8/U cables provided. Observe the labeling on the front panel type-N connectors. The blanking and sweeping connections may now be made. Use a four foot coaxial cable (RG-58/U) with BNC on one end a G.R. plug on other. Connect the BNC to the panel jack marked BLANKING; connect the other end to the CATHODE BLANKING terminals on the back of the 545 or 536 Tektronix oscilloscope. Use a four foot RG-58/U cable with BNCs on both ends to connect the sweep output of the transceiver to the horizontal input of the oscilloscope. This provides the time base for the display. The INTENSITY control on the oscilloscope may be adjusted to get best results from the blanking. Adjust the SWEEP WIDTH control on the transceiver so that it will sweep the full width of the screen.

Connect the four video outputs from the transceiver to the 1A4 four-channel plug-in amplifier. The operator will probably want to connect the RECEIVER VIDEO to the top channel, the X to the second, the Y to the third, and the Z to the fourth. NOTE: the polarity of the X, Y & Z outputs is negative, therefore, the "invert" knob on these three channels of the 1A4 amplifier must be pulled out to get a positive-going display. The sum output may be used in place of one of the X, Y or Z inputs. When it is used the "invert" knob must be pushed in to get a positive going display, because the "sum" signal is positive going. The next step is to position the transmitting antenna so that it floods the target antenna. The receiving antenna should also face toward the target and should be spaced about 6 feet from the transmitting antenna. To get a feel for the systems operation, try polarizing the target antennas as follows: the target's "X" axis should be positioned so that it's long axis is perpendicular to the line of sight between the transceiver and the target antenna. The receiving and the transmitting antennas' log-periodic antennas should be in the same plane as the target antenna (i.e., horizontal and perpendicular to the line of site.). Figure 18 is a pictorial view of the operational setup.

The transceiver should be plugged into 117 V 60 Hz and the power switch should be turned on, COMPENSATION switch off and TRANSMIT MODULATION switch on. The SWEEP SECONDS should be set to 0.3 and the SWEEP WIDTH control adjusted to full CW position. The marker amplitude control may be adjusted to full CCW (minimum marker amplitude). Video signals should appear on all four oscilloscope channels.

The X channel should have the largest amplitude. The Y & Z displays should be much lower because they are cross-polarized with the transmitting and receiving antennas.

3.4 Operation

The BAND GHZ selector switch is used to select the frequency range of interest. The low band is 0.8 to 1.2 GHz and the high band is 1.2 - 2.0 GHz. The CENTER FREQUENCY control is used (on both the high and low bands) to adjust the center frequency while sweeping a narrow band of frequencies. When the SWEEP WIDTH control is adjusted full CCW, the sweep to the VTO's is off and the CENTER FREQUENCY control knob may be used to adjust the frequency of the VTO's, using the calibrated FREQUENCY meter scales. When SWEEP

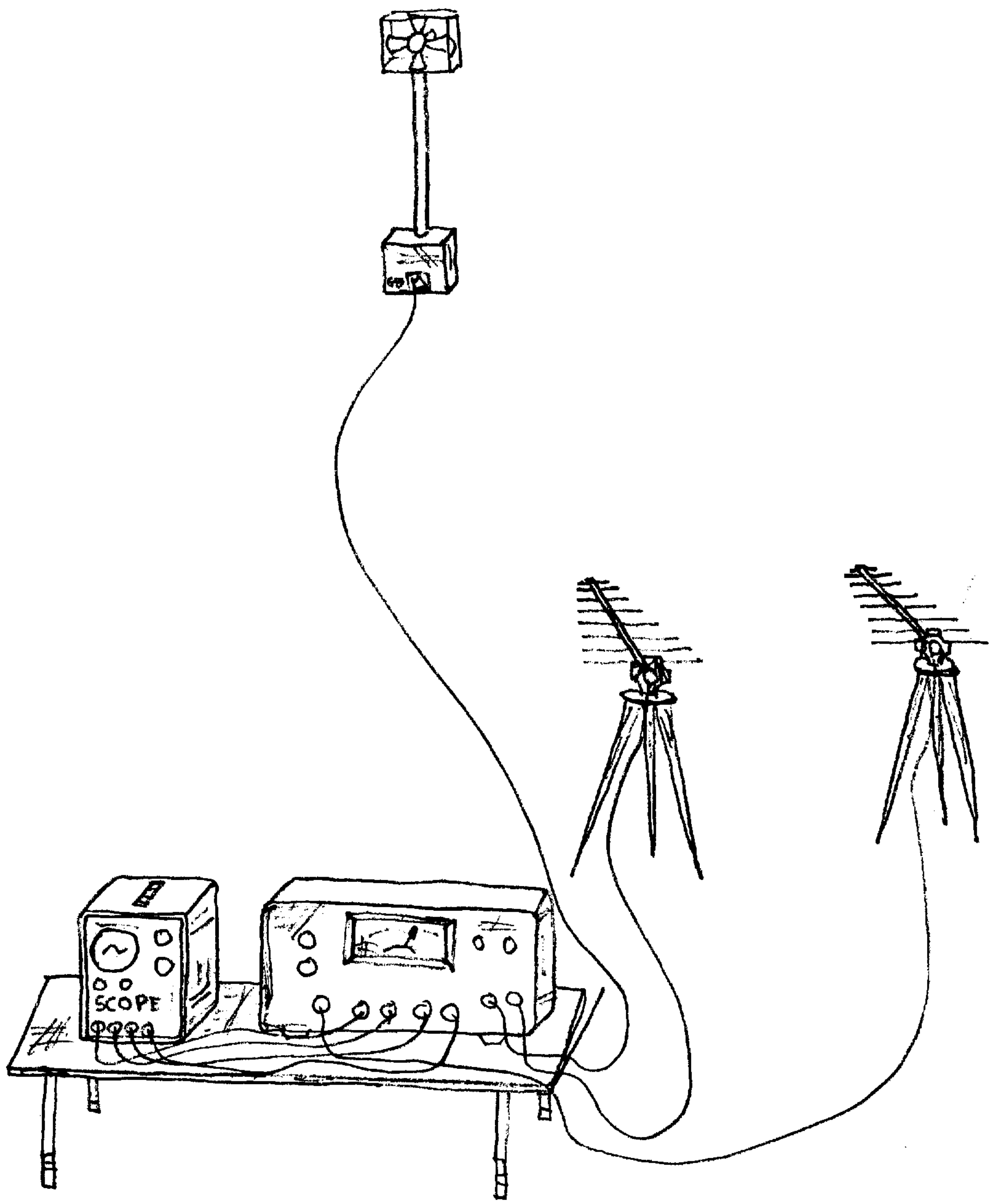

Figure 18. Operational Setup

WIDTH is adjusted full CW the CENTER FREQUENCY setting is not in operation, i.e., it can be set at any frequency on the meter but will not change the sweep width or center frequency. The best way to adjust the CENTER FREQUENCY to observe signals in a narrow sweep width is as follows: adjust the CENTER FREQUENCY control, using the FREQUENCY meter, to obtain the desired frequency. Turn the SWEEP WIDTH control full CCW. The oscilloscope display will now indicate the amplitude of signal for that frequency. Turn the SWEEP WIDTH control CW a small amount at a time until one or two 100 MHz marker pulses are observed (adjust the MARKER AMPLITUDE control for easily seen markers). Example: Use high band, turn BAND selector to 1.2-2.0 GHz, set frequency on meter dial to 1.6 GHz with CENTER FREQUENCY control. Turn SWEEP WIDTH control full CCW. Turn sweep width control CW until you see three marker lines on the oscilloscope display. These will occur every 100 MHz. There should be one at 1.5, 1.6 and 1.7 GHz. The display shows a swept frequency band of 1.5 to 1.7 GHz centered at 1.6 GHz. The center frequency may be moved higher or lower in frequency while the sweep width stays about the same. However, due to some non-linear elements in the sweep, the sweep width may have to be readjusted when the center frequency is moved. Use the 100-MHz markers as frequency-limit indicators. The low band is adjusted and operated the same way. The control marked SWEEP SECONDS controls the total time in seconds of each sweep.

The DIRECT VIDEO panel jack is connected to the Sage mixer's output where direct or raw video signals may be observed.

The switch marked COMPENSATION ON is used when free space compensation is desired. The initial setup of the free-space compensation should be carried out in a reflection-free environment. A large low frequency anechoic chamber with cutoff below 0.7 GHz, would be the best place to adjust the compensation circuits. It is suggested that the target antenna be placed at one end of the chamber, the transmitter and receiver at the other end. The transmitter antenna should flood the target antenna and the receiver antenna should be placed in its most favorable position to receive reflected rf from the target.

The inherent isolation between the receiver and transmitter antennas due to the 170 kHz coding of the signal should be enough to get a clear uncluttered video signal from the target-video output. The object of the compensating technique is to have a leveled target-video display; i.e., there are many non-linear elements with frequency, in the total system: all three antennas, the VTO's, low pass filters, microwave isolators and transmission lines. They distort the true reflections of the target antenna. Therefore, by adding or subtracting (as the video picture indicates) eight contiguous d.c. levels for each sweep, the above mentioned distortions will be reduced. There is a separate compensating circuit for each band. See Figure 6 for the physical location of circuit cards. The calibration method is carried out in the following way:

1. Set the system up in the anechoic chamber
2. Remove the top cover of the transceiver
3. Turn on power and set the TRANSMIT MODULATION switch to the off position. Turn the sweep width control fully clockwise. Set the BAND switch to the band to be compensated.

4. Observe the receiver video output on the oscilloscope with the COMPENSATION switch in off position. The receiver video output (the amplitude-frequency display) d. c. envelope will not be a level line, it will be distorted for reasons given the preceeding text.

5. Adjust the Free Space Compensation circuit to obtain the most level line. The 8 miniature trim pots on the top edge of the low and high-frequency-band circuit boards are used to adjust the compensation (see Figure 6). Turn on the COMPENSATION switch. Observe the video output; there should be 8 dc steps in the video envelope. The object of the compensation circuits is to make the line as level as possible by adjusting the trim pots. Start at the left end of the circuit board; this corresponds to start of the sweep (the low frequency end), and adjust each potentiometer for the best results. Switch bands and adjust the compensation potentiometers on the other circuit board in the same way.

4.0 MAINTENANCE

Occasionally it may be necessary to retune some amplifiers and adjust gains and dc levels.

4.1 Target Amplifier Tuning

The antenna base for the remote antenna contains 3 tuned amplifiers (X, Y & Z), and one antenna chopper driver. The frequency response three 100-kHz tuned amplifier's (see Figure 18) may need to be peaked and Q & gain adjusted.

a. Remove covers as shown in Figure 19.

b. Make sure all three antennas are plugged in and that all connecting cables except the TRANSMIT ANTENNA cable and antenna are connected in their normal way.

c. Turn on POWER and TRANSMIT MODULATION

d. Turn SWEEP WIDTH to zero (CCW), adjust, using either band, the CENTER FREQUENCY control to some convenient frequency that can be seen on the display (X, Y or Z video).

e. Unplug, one at a time, each antenna connector and substitute for it the Target Amplifier Calibrator. This calibrator takes the transmitted signal and gives a video output of proper level for amplifier adjustment. Its circuit is shown in Figure 20. NOTE: It is very important to have the other two antennas plugged into their appropriate connectors when adjusting an amplifier with the Target Amplifier Calibrator.

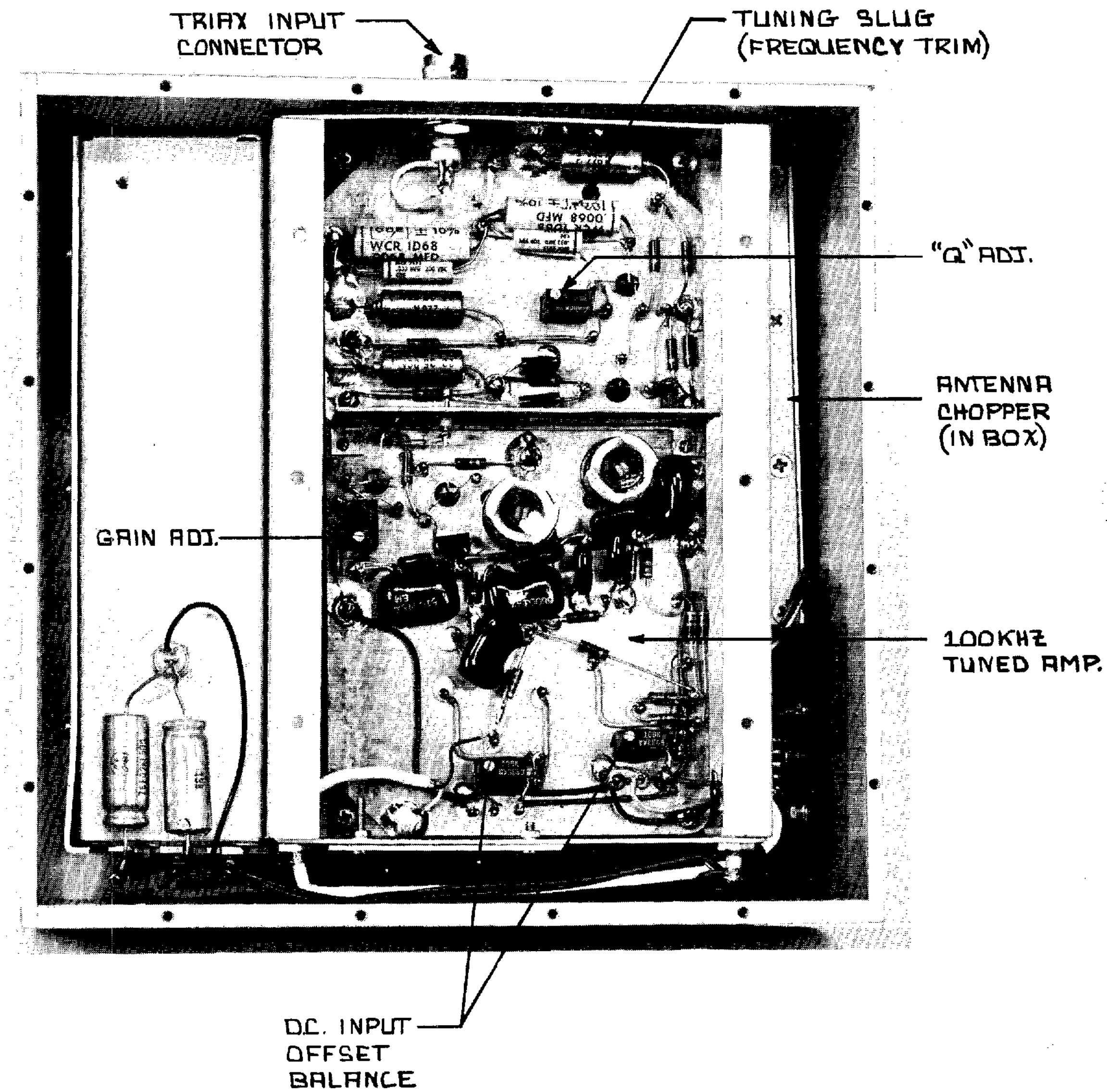

Figure 19. Target Antenna Base (Preamplifier Module) with Cover Removed

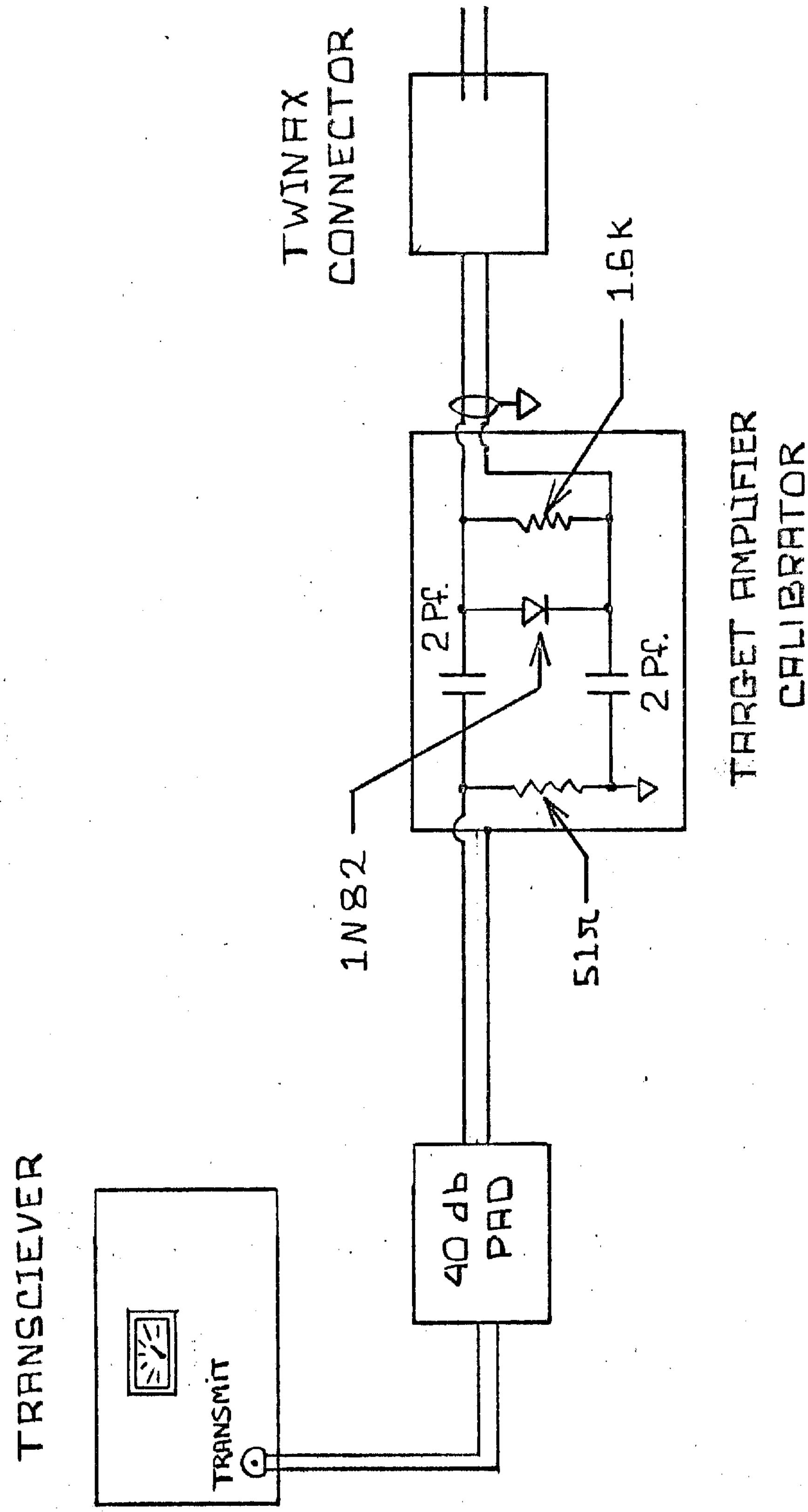

FIGURE 20. USE OF TARGET AMPLIFIER CALIBRATOR

f. If for example the X amplifier is to be calibrated first, it would be unplugged and the calibrator plugged in. The X target video output will be observed on the oscilloscope. Use a small screwdriver and carefully peak the output response by adjusting the tuning slug shown in Figure 19.

g. The Q adjustment does not need adjustment unless components have to be replaced. If adjustment is needed - adjust as follows: advance the adjusting screw on the trim pot until the circuit oscillates - then back off several turns until the circuit is stable.

h. The "gain adjust" potentiometer changes the gain of the last ac stage of the amplifier. It may be necessary to adjust each control to make all three amplifiers have the same output levels. The dc input off-set balance potentiometers shown in Figure 19 need adjustment only if the operational amplifiers are replaced.

4.2 Antenna Chopper Adjustment

The antenna chopper is in a small box in the target antenna base. There are two trimpots, one for a minor frequency adjustment and the other adjusts the square wave symmetry. These will probably not need adjustment unless components are replaced. NOTE: if the frequency needs to be peaked this may be done in the "receiver video" amplifiers in the transceiver rather than in the antenna chopper circuit.

4.3 Receiver Video Amplifier Tuning

The receiver video amplifier (See Figure 10) is tuned the same as the target antenna. The difference is the method of signal insertion.

a. The complete system should be assembled - all cables and antennas.

b. Place the target antenna close to the transmitting and receiving antennas (about 50 feet). Flood the target with the transmitting antenna and receive the reflection on the receiving antenna. Observe the RECEIVER VIDEO output.

c. Remove the chassis side and amplifier cover. Refer to Figure 19 for parts location as the layout is the same as the target preamplifier. Tune the same way as the remote antenna preamplifiers. NOTE: Turn transmit modulation off, sweep width to zero, adjust center frequency to a convenient spot, observe signal on "RECEIVER VIDEO", tune for maximum output.

4.4 100-kHz Driver Adjustment

The 100 kHz driver (See Figure 19) has a fine-frequency control and a square-wave symmetry adjustment. It is preferred not to adjust the frequency of this circuit but adjust the 3 target preamplifiers instead. If components are replaced, then the frequency adjustment should be made and the square wave adjusted so the on-off time periods are equal.

4.5 Log Amplifier Adjustment

The target and receiver log amps may be adjusted as follows:

a. The transceiver should be plugged into the power line, the target cable should be connected from the transceiver to the target - TRANSMIT MODULATION off, COMPENSATION OFF. The X, Y & Z target video outputs connected to the scope. A 1X scope probe must be hooked to the receiver log amplifier, output terminal (See Figure 6).

b. Neither the transmit or the receiver antennas should be connected.

c. The blanking and sweep connections should be made to the oscilloscope.

d. Each log amp board is labeled "slope", "ref" & "zero". The slope adjustment trim pot is used to adjust the slope of the input-output transfer function. The slope has been adjusted (and need not be readjusted unless components are replaced) to fit the transfer characteristic in Figure 11.

e. The "ref" trim pot adjusts the output level of the log amp. Normally the output should be zero with no signal in.

f. Check the X, Y, Z and receiver log amp outputs on the scope; the output of all should be close to zero. If not and they are slightly off, adjust the "ref" trim pots to indicate zero output.

g. Unplug the target cable from the front panel of the transceiver. Turn "power" off.

h. Connect (clip leads) X, Y, Z and receiver inputs together. Use the terminals under the "R" in "zero". Observe the output of all 4 log amps on the oscilloscope.

i. Feed in between (com.) ground and the 4 parallel inputs the following + voltages and look for output voltages as shown.

Input	Output
+.01 dc in	zero out
+0.1 in =	-1.0 V dc out
+ 1.0 in =	-2.0 V dc out
+10.0 V in =	-3.0 V dc out

If the output needs adjustment, use the slope trim pots to adjust the output voltage to the voltages indicated.

4.6 100 MHz Crystal Marker

The 100 MHz crystal marker may need to be tuned if parts are replaced. The crystal oscillator is the only part of the circuit that needs adjustment. The ceramic 2-8 pF trimmer can be adjusted from the top of the crystal marker box (See Figure 6). There is a short loop of wire on the outside of the box. The lead from the 9 volt zener diode regulator to the crystal oscillator that an ac probe may be clamped around. The trimmer should be carefully tuned so that the oscillator draws 5 ma.

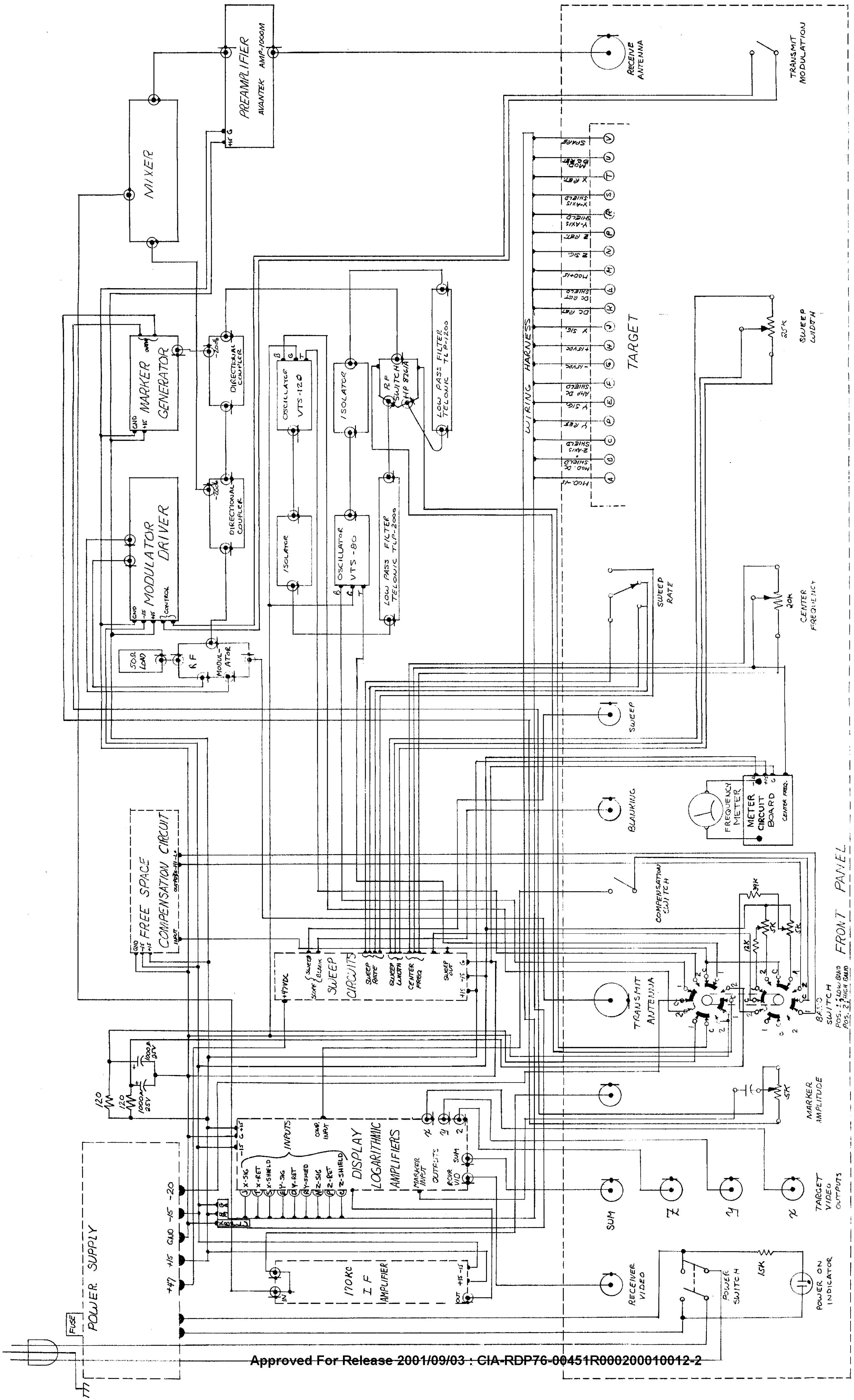

Figure 21. Path Loss Analyzer Wiring Diagram